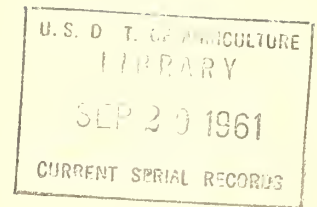


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handling
PEA BEANS
in country elevators

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
Transportation and Facilities Research Division
and Market Quality Research Division

In Cooperation with
MICHIGAN STATE UNIVERSITY
Agricultural Experiment Station

MARKETING RESEARCH REPORT NO. 479

PREFACE

The research on which this report is based is part of a broader research project on the conditioning and storage of dry edible beans in commercial elevators. While the scope and period of the studies were limited the information gained from the studies and presented in this report should be of value to operators of country elevators handling pea beans. This research was conducted in cooperation with the Agricultural Engineering and the Botany and Plant Pathology Departments of the Michigan Agricultural Experiment Station.

The work was under the supervision of Leo E. Holman, agricultural engineer, Agricultural Marketing Service, who also assisted in assembling and preparing material for the report. Acknowledgment is made of the cooperation and assistance given by operators of bean elevators.

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SUMMARY

Pea beans are harvested by combine and moved to market in a relatively short time. Country elevators, therefore, must be prepared to receive the beans in a hurry and to handle and store them until they move to processing plants. Most beans are cleaned upon receipt and the producer is paid on the basis of the weight of cleaned beans. Observations made in a limited number of elevators indicated that the cleaner was a major bottleneck. Usually, the rate at which a cleaner operates controls the rate at which beans can be received. Some of the cleaners observed were not operating according to the manufacturer's recommendations and this affected the rate at which the beans were being cleaned. In one test the average cleaning rate was increased from 545 bushels per hour to 633 by using a scalper screen with larger holes and by reducing the vibration rate of the cleaning shoes from 580 vibrations per minute to 430.

The floor-mounted, hopper-type scales with single weighing beam in a number of elevators had to be watched constantly to keep the scale hopper from overflowing. In contrast, automatic scales required attention only once during the cleaning and weighing of a load of beans and that was when the final incomplete draft was weighed.

Studies of bagging, sewing, and handling 100-pound bags of beans in country elevators in Michigan showed the rate of bagging and sewing depends on the type and layout of equipment. For example, a 3-man crew bagged 300 bags per hour using a stationary sewing machine with dolly and a semiautomatic bagging scale when each man did a single job such as bag, sew, or stack bags on a handtruck. But a 2-man crew also bagged 300 bags per hour with the same equipment when the sewing operator stacked the bags on a handtruck. It was estimated that using the 2-man crew rather than the 3-man crew could save up to \$500 a year in an elevator handling 100,000 bags per year and reduce unproductive crew labor from about 42 percent to 7.5 percent. A 2-man crew using a stationary sewing machine with conveyor increased the bagging rate to 353 bags per hour. Also, a 2-man crew using a portable sewing machine bagged 375 bags per hour by alternating their jobs with each bag filled and sewn.

At most elevators bags were moved in flat storage with handtrucks and elevated to the top of the bag pile with a short conveyor. Research studies and industry experience indicated that bags could be piled with nearly 50 percent less labor when a fork truck and pallet system was used.

HANDLING PEA BEANS IN COUNTRY ELEVATORS

by

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INTRODUCTION

Since 1950, farmers have changed from old threshing methods to new and faster combine methods of harvesting dry edible beans. This technological change has had two effects on the bean industry. Local elevators must handle the crop faster. Where once the harvest lasted for months, it now requires only a few weeks. The second effect has been the change in the condition of the beans received at the elevators. Combine harvesting may cause more damage to the bean and make it split more easily when handled at the elevator. Also, the combined beans may contain more field stones and dirt than those threshed with stationary equipment.

Since 1955 the trend has been to increase the storage capacity of country elevators in Michigan. These elevators need larger handling equipment and more efficient work methods in order to handle the beans faster. Too often, farmers have had to wait several hours to unload.

Formerly, Michigan State laws specified that graded beans had to be bagged for shipment out of the State. State regulations now permit bulk shipments of graded beans out of the state, and a gradual change in work methods and elevator facilities is expected to take advantage of the cost saving in bulk handling methods. A complete changeover to bulk handling may not occur, however, as pea beans for seed may continue to be handled in 100-pound burlap bags.

Beans generally can be handled in bulk with the same equipment that is used for handling other seeds and grain. They can be safely stored in vertical or flat storages with little turning if aeration systems are used to cool the beans and to prevent moisture migration. ^{1/} Less labor is required to ship bulk beans than bagged beans. Dry pea beans are more subject to breakage than other seeds or grains, however, so more care is needed when handling and shipping beans in bulk.

Handling studies were made in six country elevators in Michigan where pea beans are received from farms, cleaned, stored, and then shipped to processors or terminal elevators. Industrial engineering techniques including time and

^{1/} Perry, John S. Aeration of Bulk-Stored Pea Beans. U. S. Dept. Agr., Mktg. Res. Rpt. No.

motion studies were used to collect and analyze handling data. Requirements for labor and equipment were determined for certain work in handling beans. Assumed wage rates were used to convert man-hours of labor to dollar costs and added to this were the costs of ownership and operation of equipment to provide a total cost for the operations. Also, information was developed as to proper crew organization for certain jobs.

RECEIVING OPERATIONS

Beans received at country elevators often contain a considerable amount of foreign material. Before the beans can be safely stored, much of this foreign material must be removed. It is an industry practice to clean the beans and then weigh the cleaned beans as a basis of payment.

Receiving beans consisted of six major operations: (1) Dumping into a receiving pit; (2) cleaning; (3) bagging-off foreign material; (4) weighing cleaned beans; (5) sampling cleaned beans; and (6) moving the cleaned beans to storage.

The following types of equipment were in use during the study (fig. 1): (1) A dump or receiving pit large enough to hold a truck- or wagon-load of beans; (2) air-screen cleaner with double cleaning shoes and overhead garner bin; (3) hopper scale with a balance arm and loose weights for weighing the cleaned beans; (4) a garner bin above the scale to hold the cleaned beans during the weighing operation; (5) a grain probe (or trier) and a small can to hold the samples; and (5) a small bin, serviced by a short bucket-elevator, to hold refuse from the cleaner until it could be bagged off and set aside for disposal.

Dumping

The equipment used for dumping a load of beans consists of an electric hoist for raising trucks not equipped with a hydraulic truck bed lift, and a dump pit for holding the load temporarily until the previous load has been cleaned. The pit should be large enough to hold an entire load at one time. A smaller pit can delay dumping.

The labor used in dumping is largely that of the truckdriver. In most bean elevators, he drives his truck into the elevator driveway, positions the truck endgate over the dump pit, opens the endgate, raises the truck bed, and dumps the load. After the beans have been dumped into the pit, he closes the endgate, lowers the truck bed, and drives out of the elevator driveway. An elevator employee may assist by raising and lowering the truck with the electric hoist if the truck is not equipped with a hydraulic bed lift. Stopping and restarting the hoist while raising the truck increases the labor required for the employee in dumping each load.

Cleaning

The equipment usually used in cleaning is a bucket-type elevator for raising the beans from the pit to an overhead garner bin, and an air-screen

FLOW DIAGRAM FOR RECEIVING AND CLEANING PEA BEANS AT COUNTRY ELEVATORS

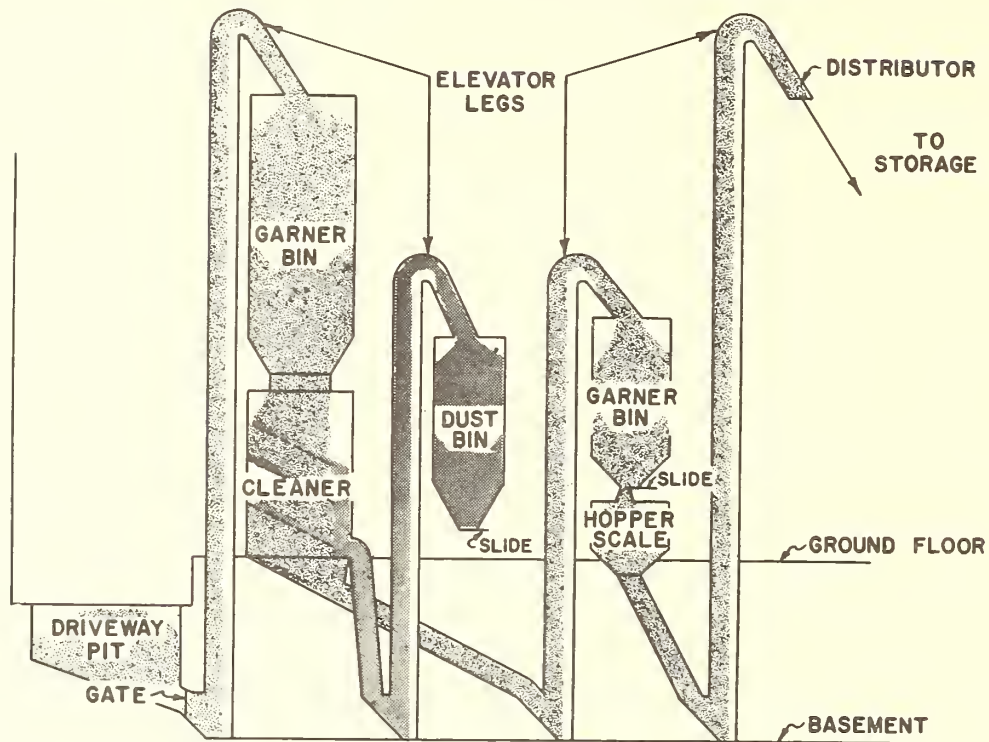


Figure 1

cleaner with one or two cleaning shoes. The cleaner can operate more efficiently when the supply of beans from the elevator leg exceeds the capacity of the cleaner.

The labor required for cleaning generally is supplied by one of the elevator employees. He opens the pit gate to let beans flow from the pit into the bucket elevator; when the pit is empty, he closes the gate before dumping the next truckload. He also periodically attends the cleaner to inspect cleaning quality and make adjustments.

Normally, the rate of cleaning plus the delay or wait time between loads moving into the cleaner determine the rate at which the elevator can receive beans. An elevator operator can best serve his customers and himself by minimizing the delay between truckloads.

The following examples illustrate the effects of delays in the cleaning operation: A bean cleaner with a cleaning capacity of 600 bushels (36,000 pounds) per hour can clean a 6,000-pound load of beans in 10 minutes. With no delays between loads, 6 loads could be received in an hour. But with a 2-minute delay between each load, only 5 loads could be received per hour. Thus, during a 12-hour day, elevator receipts would drop from 432,000 pounds of beans to 360,000 pounds with a 2-minute delay between loads and to 288,000 pounds with a 5-minute delay between loads. This would amount to a 16½- to 33-

percent reduction in bean receipts for each day of operation. Delays also increase the cost per load of beans received, as the daily costs would be about the same in spite of the reduced volume.

Operators of several of the cleaners included in the study did not follow the manufacturer's recommendations as to the vibration rate of the cleaning shoe and the size of the scalper screen. A high rate of vibration caused the beans to move over the screens with considerable bouncing rather than a desired tumbling action. At the higher vibration rates, the beans moved farther down the screen before falling through. The cleaning rate was controlled by the rate of vibration and the flow of beans to the cleaner. If the rate of vibration was increased it was usually necessary to slow down the flow of beans to the cleaner.

The screens of a bean cleaner are so arranged that the beans pass through the holes of a scalper screen and then onto the screens of a cleaning shoe. The scalper screen is a short screen which removes only the largest foreign material such as clods, rocks, or bean pods. The smaller foreign material is removed by screens in the cleaning shoe.

A cleaning shoe normally is composed of two screens. The grading or first screen is designed to remove extra-large beans with a high-moisture content and dirt clods or rocks somewhat larger than a normal-sized bean. The second screen has slotted openings that hold back normal-sized beans and allow split beans and fine foreign material to fall through. A cleaner operating at capacity will have the second screen sufficiently "loaded" with beans to maintain the capacity without overloading to the point of reducing cleaning efficiency.

Using a scalper screen with openings smaller than recommended decreased the capacity of the cleaner. The smaller openings became clogged with the particles of foreign material. Then the beans piled up on the scalper screen and overflowed with the bean pods, large rocks, and dirt clods. It was then necessary to decrease the feed rate, which reduced the capacity of the cleaner.

Detailed observations were made on one cleaner, which handled 55 loads of beans during the test. The scalper screen on the cleaner had round holes 28/64-inch in diameter; the minimum recommended by the manufacturer was 36/64-inch. The feed rate was adjusted and maintained to insure adequate cleaning quality and to prevent any overflow of beans from the scalper screen. The cleaning shoes had a vibration rate of 580 vibrations per minute; the rate recommended by the manufacturer was 425 per minute. The foreign material coming from the scalper screen from each individual load was caught and weighed. The weight of the cleaned beans in each load was obtained from the elevator weight ticket and the cleaning time for each load was determined by a stopwatch. The average cleaning rate during the test was 545 bushels per hour. It ranged between 420 and 695 bushels per hour depending upon the amount of foreign material in the beans, the weather, and operating procedures.

In a later test a scalper screen with 32/64-inch round holes was used and the vibration rate of the cleaning shoes was reduced to 430 vibrations per minute. Then the average cleaning rate increased from 545 up to 633 bushels per hour. The amounts of foreign material in this test were similar to the amounts found in the previous test.

With the larger openings in the scalper screen there was no clogging, and a faster feed rate could be maintained. The increased volume of beans was cleaned satisfactorily at the slower vibration rate of the cleaning shoes.

With a cleaner operating at an average rate of 545 bushels per hour, and with no delays between loads moving into the cleaner, 5.5 truckloads can be received per hour if each load averages 6,000 pounds. With the cleaner operating at 633 bushels per hour, 6.3 truckloads can be received per hour, an increase of about 14½ percent in the receiving rate.

Bagging-Off

A bucket-type elevator and a metal, wooden, or concrete dust bin with a slide or gate in the bottom usually are used for bagging-off cleanings and dirt from the cleaner. The elevator picks up the refuse from the waste chute of the cleaner and carries it to an overhead bin.

Several empty burlap bags usually are stored beside the bag-off spout of the bin. Dirt, pods, and stones removed by the cleaner are put in these bags and set aside for later disposal. Whenever possible, bags are emptied during slack periods when beans are not being received. But occasionally operations must stop long enough for some bags to be emptied. Filled bags are emptied into a truck, and the empty bags returned to the storage beside the spout. During the cleaning of an average load of beans in the 1958 season, about 1½ bags of material were accumulated.

The disadvantage of a dust bin arrangement of this type is that the manual handling of cleanings is a time-consuming, dirty task which would best be mechanized to relieve employees for more useful tasks.

Bins with spouts to an outside disposal point would relieve dusty conditions in the receiving area and considerably reduce the labor required.

Weighing

Most of the elevators studied had floor-mounted, hopper-type scales with a single weighing beam and several loose weights. The maximum weighing capacity was 6,000 pounds. A small garner bin above the scale held the cleaned beans while the hopper load was being weighed and dumped. A horizontal slide in the garner bin controlled the flow of beans from the bin to the scale hopper.

Pre-weighing operations consist of opening the garner bin slide to allow cleaned beans to fill the hopper and adjusting the scale beam weights to indicate the desired hopper load. A separate ticket usually is issued for each truckload of beans.

While waiting for the scale hopper to fill, the employee may do other jobs such as raising or lowering a truck, sampling the beans, bagging cleanings from the dust bin, and adjusting and inspecting the operation of the bean cleaner. When the scale hopper is full, the slide in the garner bin is closed and the beans weighed. If the hopper is allowed to overfill, more loose weights must

be added to the beam; if not sufficiently filled, some weights must be removed. Once the weight is determined, it is recorded on the ticket and the hopper is emptied. When the hopper is empty, the scale hopper gate is closed and the garner slide opened to repeat the weighing operation.

A scale of this type requires careful attention to prevent overfilling of the scale hopper when beans are allowed to flow constantly into the hopper.

One elevator operator allowed the garner to fill and then released enough beans to fill the scale hopper. This method required even more labor than a constant flow from the garner bin as the operator had to hold the garner gate open during the filling.

Automatic receiving scales are available for weighing beans in lots of 6, 10, 15, or 25 bushels (360, 600, 900, and 1,500 pounds). Such scales require attention only once during the cleaning and weighing of a load. The final incomplete draft is weighed manually with an attached beam and sliding weight. The total weight of a load can be recorded easily on a scale ticket or printed on a card for recording.

Sampling

Samples of cleaned beans usually are obtained with a grain probe (trier), a small can, or a hand scoop.

Probe sampling consists of picking up the probe from a rack, inserting it into the beans in the scale hopper, filling the probe, withdrawing it, pouring the sample into a pan, and returning the probe to the rack.

With can or scoop sampling, the can or scoop is dipped into the beans in the scale hopper or held under the garner bin spout. This method of sampling was not studied.

There were a few types of automatic grain samplers on the market. They can be placed in the head of the elevator leg that carries beans from the cleaner to the garner bin, inside the garner bin, or in the spout from the garner bin to the hopper scale. A tube or a rotating deflector cuts the bean stream and diverts a small part of the beans to a sample container. These samplers will collect a truly representative sample throughout the cleaning period and hold it for the operator at any convenient location. Thus, sampling a load of beans is reduced to merely picking up the sample from a convenient location, in any desired size of container, and testing or labeling the sample.

Moving Beans to Storage

Beans, after weighing, were moved to storage by a bucket elevator (fig. 1), a distributor, and several metal or wood spouts. The distributor normally was located above the bins. As the distributor must be moved to the proper position for filling the selected storage bin, the operator either had a remote control device for controlling its operation from the main floor or he had to go to the top floor and manually position it. A remote control eliminated the labor

required to manually set the distributor at the top of the elevator. A remote control device was used to position the distributor spout about every third load.

CLEANING OPERATIONS

Figure 2 shows the activities involved in cleaning a 9,700-pound load of beans at 545 bushels per hour, and the productive and unproductive time of the operator. Table 1 shows the amount of time spent by the operator on each activity--weighing, sampling, bagging-off cleanings, inspection, and other miscellaneous jobs--carried out during the cleaning operation.

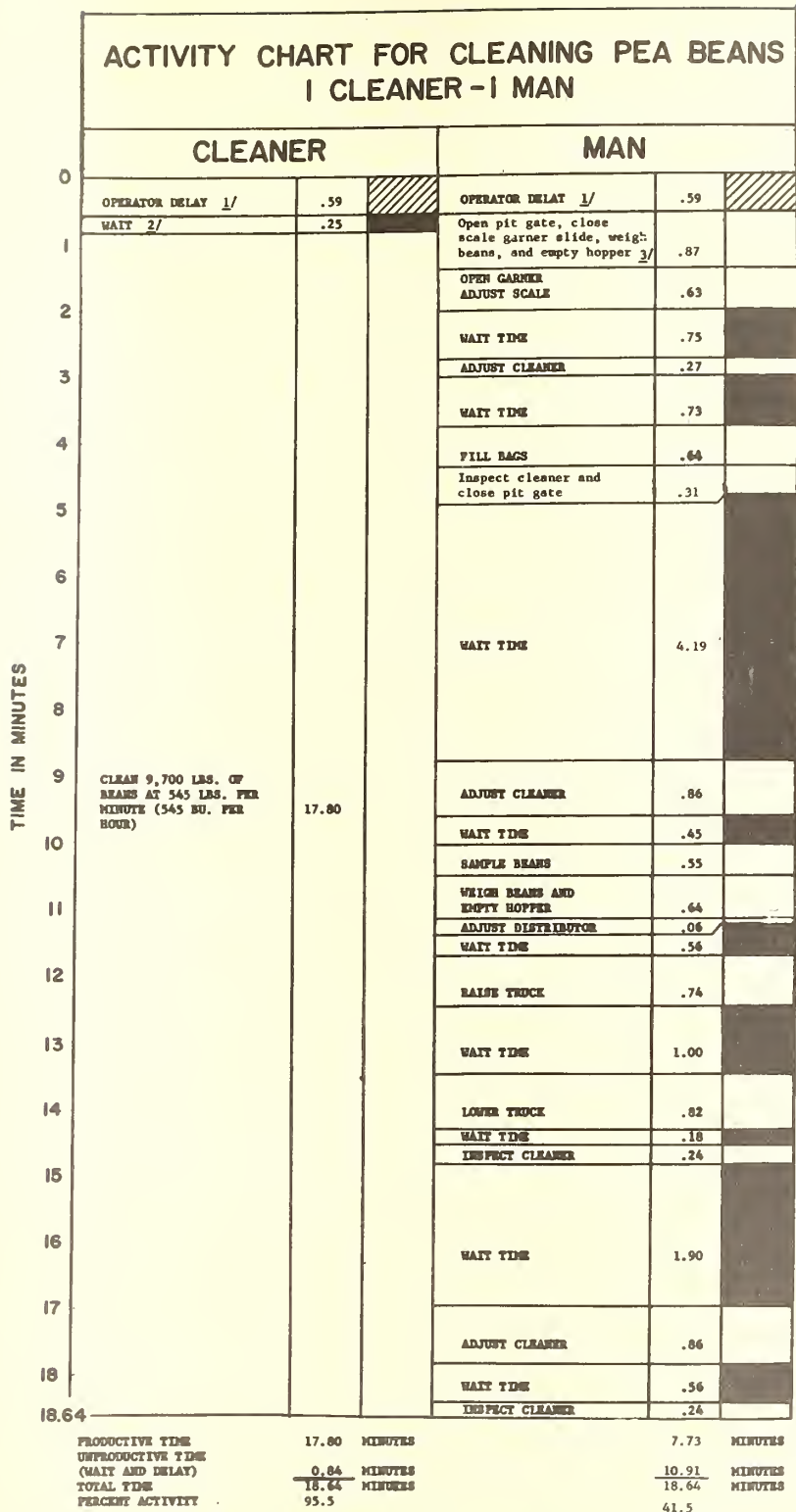
Table 1.--Productive and unproductive time of cleaner and operator for cleaning one load of beans 1/

Item	Operator					Cleaner
	: Weighing :	: Sampling :	: Bagging-off :	: Inspection and miscel- : : laneous :	: Total time :	
	: <u>Minutes</u> :	: <u>Minutes</u> :	: <u>Minutes</u> :	: <u>Minutes</u> :	: <u>Minutes</u> :	: <u>Minutes</u> :
Productive time.....	: 2.11 :	: 0.55 :	: 0.64 :	: 4.43 :	: 7.73 :	: 17.80 :
Unproductive (wait and delay) time.....	: - :	: - :	: - :	: - :	: 10.91 :	: .84 :
Total cleaning time...	: - :	: - :	: - :	: - :	: 18.64 :	: 18.64 :
	: <u>Percent</u> :	: <u>Percent</u> :	: <u>Percent</u> :	: <u>Percent</u> :	: <u>Percent</u> :	: <u>Percent</u> :
Productive time as percentage of total cleaning time.....	: 11.3 :	: 3.0 :	: 3.4 :	: 23.8 :	: 41.5 :	: 95.5 :

1/ 9,700-pound load cleaned at a rate of 545 bushels per hour.

The bean cleaner studied was of the air-screen type commonly used in Michigan. A load of beans (9,700 pounds) was cleaned in 17.8 minutes, a rate of 545 bushels (32,700 pounds) per hour. The size of the load and the cleaning rate were average for all loads from which data were obtained during the receiving studies. Between each load there was a combined delay and wait time of 0.84 minute before the cleaner began to clean the next load.

The operator delay time, 0.59 minute, was avoidable delay caused by the operator not opening the dump pit slide as soon as the cleaner had finished cleaning the previous load. The wait time for the cleaner, 0.25 minute, was unavoidable wait time required for the beans to go from the pit, up the elevating leg into the garner bin above the cleaner, and then onto the screens of the cleaner. The cleaner, therefore, was operating (productively) only 95.5 percent of the time.



- 1/ OPERATOR DELAY TIME - AVOIDABLE DELAY CAUSED BY THE OPERATOR NOT OPENING DUMP PIT SLIDE AS SOON AS CLEANER HAD FINISHED CLEANING PREVIOUS LOAD.
- 2/ UNAVOIDABLE WAIT TIME REQUIRED FOR BEANS TO GO FROM PIT INTO GARNER BINS OVER THE CLEANER.
- 3/ OVERLAP - (.62 MINUTE OVERLAP) COMPLETION OF WEIGHING OF PREVIOUS LOAD IS DONE AFTER CLEANING OF NEXT LOAD IS STARTED.



Figure 2

In some elevators there often was more avoidable delay than that shown in figure 2. In one elevator, where studies were made on receiving, there was a 5-minute delay between loads going into the garner. As the cleaning operation is the main factor in determining the rate at which beans can be received, the dump pit slide should have been opened to start the next load into the cleaner as soon as the previous load had been cleaned. This would increase the output of the cleaner and in turn the receiving rate. During the final weighing of a load the beans from the next load could have been started moving from the pit to the cleaner. Closing the garner bin slide before the next load reached the cleaner screens would have kept the two loads separate for sampling and weighing. This method is shown in figure 2 where the completion of the weighing operation and the start of the cleaning of the next load overlapped--that is, occurred at the same time. In this case there was an overlap of 0.62 minute in the weighing and cleaning. Without this overlap there would have been a delay of about 1-3/4 minutes between loads going into the cleaner instead of 0.87 minute as the pit gate would not have been opened until after the beans in the hopper had been weighed.

The jobs in receiving were performed in no particular order; most of them could be done at any time during the cleaning cycle. The total time given (fig. 2) was the cleaning time for the average load studied plus the average delay time between loads. During the 18.64 minutes required for the cleaning cycle, the operator worked about 7-3/4 minutes or 41.5 percent of the time (productive labor). No allowance was made for different elevator layouts or for the operator to walk from job to job. Walking distances in the well planned elevator should be kept to a minimum as walking tires the operator and represents unproductive labor.

There are several ways of increasing the cleaning capacity of an elevator--with a corresponding increase in the receiving rate--without increasing labor requirements. One way is to use a larger cleaner or to use two small cleaners. Another possibility is to use two cleaners and two scales with a single elevating leg and a large dump pit serving two garner bins, one above each of the two cleaners. The first load of beans would be dumped into the pit and elevated into the bin above the first cleaner. The second load would be elevated into the bin above the second cleaner. With each cleaner having an average cleaning rate of 545 bushels per hour, the receiving rate could be increased from about three loads per hour to over six loads per hour. The two cleaners would operate about 99 percent of the time, assuming no avoidable delays between loads, and the operator would be working about 93 percent of the time.

With two cleaners and two hopper scales, the weighing operation would require about 23 percent of the operator's time. Two automatic scales instead of two hopper scales would reduce the labor required for weighing.

BAGGING AND SEWING OPERATIONS

Beans to be bagged are graded by removing the foreign material and poor quality beans. They are usually weighed into 100-pound bags and then the bag is closed with a sewing machine. After the sewing operation, the bags are moved by handtruck, fork truck, or belt conveyor to storage or shipping.

Bagging beans consists of getting an empty bag, placing it under the bean spout, filling it with beans, and setting it to one side for the sewing operation. When a bag clamp is used, the bag must be fastened before filling and unfastened after filling. Empty bags were kept on a small stand beside the scale so that the operator did not have to pick up an empty bag from the floor.

A semiautomatic portable bagging scale holding 3 bushels of beans was used in all the studies. With this type of scale the operator controlled the flow of beans into the bag.

Three types of sewing machines were used in the studies: (1) Stationary sewing machine with dolly, (2) stationary sewing machine with belt conveyor, and (3) portable sewing machine. Bag clamps were used in some of the tests with the stationary sewing machine with dolly.

Stationary Sewing Machine with Dolly

When a stationary sewing machine with dolly platform is used, the filled bag is lifted from the scale to the dolly platform where it rests during the sewing operation. The bag is then moved to a handtruck or fork truck pallet for transportation to storage or shipping (fig. 3).

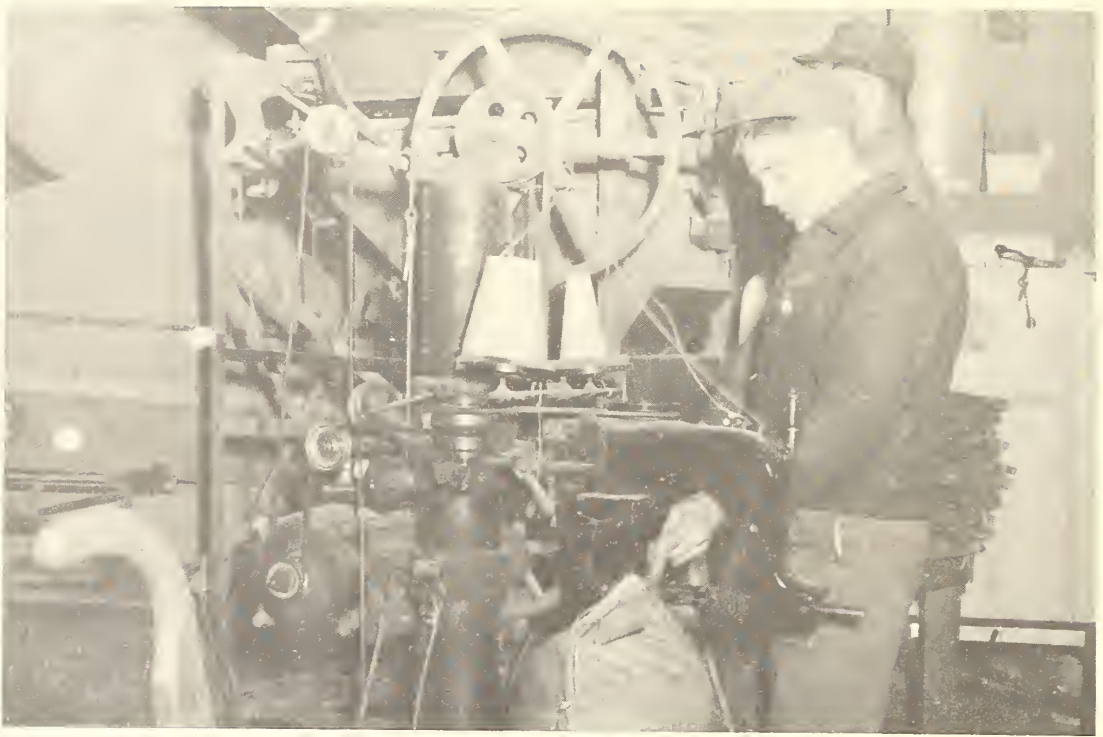
In the studies a 2-man crew (bagger and sewer), using a semiautomatic scale and bag clamp, bagged up to 222 bags per hour. The labor required per 100 bags was 54 man-minutes and the labor and equipment cost \$1.73.

Without a bag clamp, but with other equipment the same, the beans are automatically weighed into a small hopper in 100-pound lots and then released by the operator into the bag. Normally, a 2-man crew is used, with one man bagging the beans and the other sewing the bags and moving them to a handtruck or pallet. If a third man is used, he places the filled bag on the handtruck or pallet (fig. 4).

In the studies the bagging rate of either the 2- or 3-man crew, when each man performed a single operation, was 300 bags per hour. The third man did not increase the bagging output but did increase the labor cost from \$1 up to \$1.50 per 100 bags filled. The equipment cost remained the same in either case. Total labor and equipment cost per 100 bags for the 3-man crew was \$1.88 and for the 2-man crew \$1.38.

For the 2-man crew, unproductive labor amounted to 3 man-minutes for every 100 bags. This was 7.5 percent of the total labor required. The sewing operator had to wait while the bagger finished filling each bag. For the 3-man crew the unproductive labor was greater, amounting to 25 minutes for every 100 bags or nearly 42 percent of the total labor required. Here the third man, the stacking operator, was doing a job that could be done by the sewing operator. Consequently, both men had considerable wait time (fig. 5).

By alternating tasks, a 2-man crew using the same equipment bagged 324 bags per hour at a total labor and equipment cost of \$1.31 per 100 bags. With this method one man picks up an empty bag, fills it, moves it to the sewing machine, then sews it and places the sewn bag on a handtruck. Meanwhile, the second man



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Figure 3.--Sewing a 100-pound bag with a stationary sewing machine with dolly.



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Figure 4.--Three-man crew bagging, sewing, and moving bag to pallet.

ACTIVITY CHART FOR BAGGING AND SEWING OPERATIONS 1/

Time required per 100 bags; 3-man crew

Time in minutes	Bagging operator	Sewing operator		Stacking operator
		Position bag to sewing head		
0			2	
5	Get and place bag on spout of scale	7		Wait for sewer
			7	
10	Fill bag	7		Grab bag by ends
15	Shake beans down in bag	3		Move bag to hand truck
			11	
20	Move bag to sewing machine	3		Wait for bagger

6
14

9
11

Productive time (minutes) 20
Unproductive time (minutes) 0

1/ Equipment - semi-automatic portable scale (3-bushel cap.) without bag clamp and with stationary sewing machine with dolly.

□ Productive time
■ Unproductive (wait) time

Figure 5

has filled a bag and is ready to sew it when the first man is through. There is no wait time, so unproductive labor is eliminated and 100 bags can be filled in 18.5 minutes instead of 20 minutes.

Stationary Sewing Machine With Belt Conveyor

When a sewing machine is equipped with a belt conveyor, the bagging operator does not have to lift the bag from the scale to the sewing machine as the bag rests on the belt during filling. When a bag is filled the operator simply leans it against a supporting backstop, releases the bag, and reaches for an empty bag to repeat the cycle. When the sewing operator starts to sew a bag, a second filled bag should be waiting on the belt between the scale and the machine (fig. 6). The conveyor holding the filled bags moves only while the sewing machine is in operation.

Using this method, a 2-man crew bagged 353 bags per hour or 100 bags in 17 minutes. The labor required per 100 bags was 34 man-minutes and the total labor and equipment cost was \$1.30.

Portable Sewing Machine

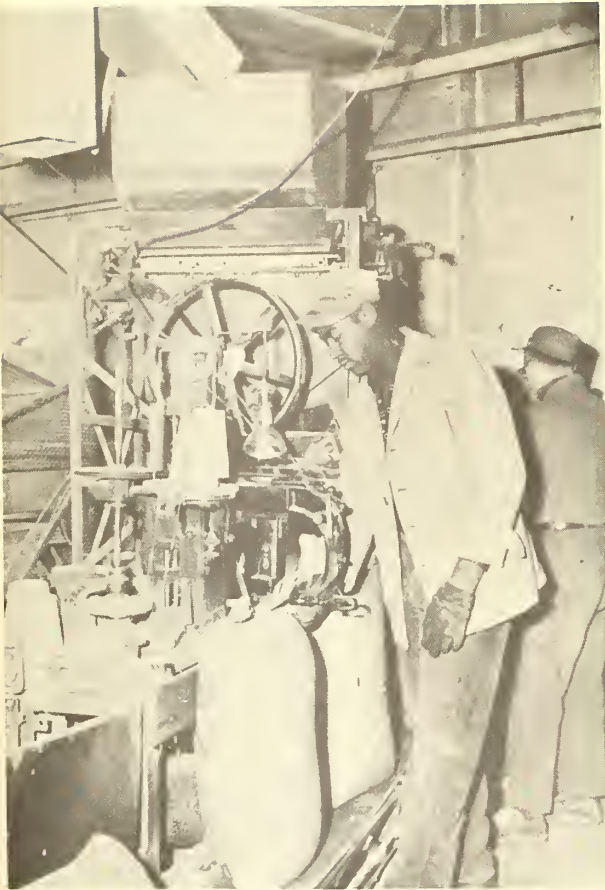
The portable sewing machine studied was suspended at an appropriate position for sewing the bag (fig. 7). By alternating the tasks, a 2-man crew using a portable machine bagged and sewed 324 bags per hour when a handtruck was used to transport the bags to storage or 375 bags per hour when a conveyor was used. The use of a conveyor eliminated the lifting of the filled bags on to the top of a handtruck load. There was no unproductive labor as neither worker had to wait for the other at any time.

The labor required to bag 100 bags in 16 minutes was 32 man-minutes; this was at a rate of 375 bags per hour. Total labor and equipment costs when using a conveyor to transport bags were \$1.09 per 100 bags, and when using a handtruck were \$1.22 per 100 bags.

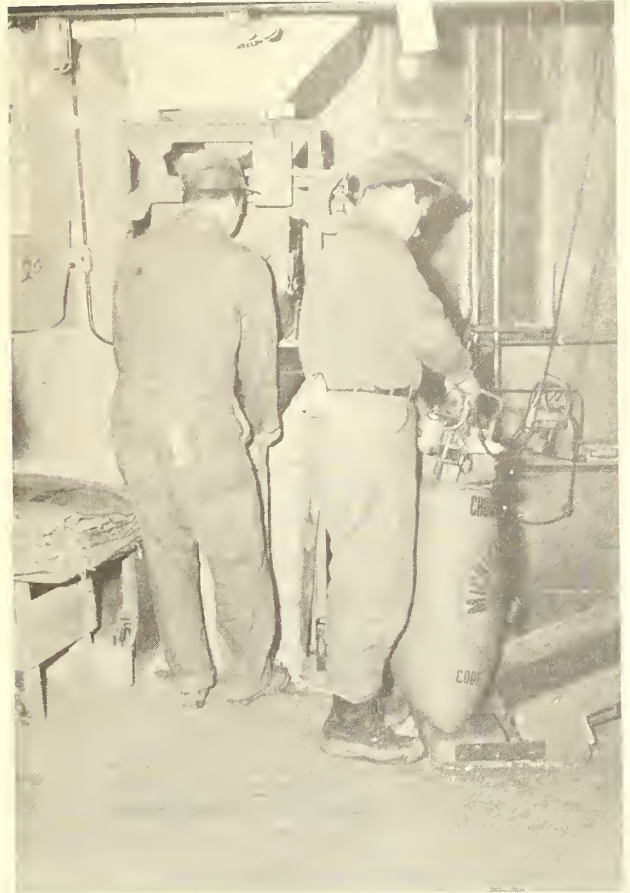
COSTS OF BAGGING AND SEWING

Comparative labor and equipment costs are given in table 2 for the seven methods of bagging and sewing studied. Estimated ownership and operating costs for the equipment used are given in table 3. A 3-man crew using a semiautomatic scale and stationary sewing machine with dolly platform filled and sewed 300 bags per hour at a labor and equipment cost of \$1.88 per 100 bags. A 2-man crew using the same equipment filled 300 bags per hour at a saving of 26.5 percent. The 2-man crew by alternating their tasks instead of each performing a single operation increased their bagging rate to 324 bags per hour and reduced the cost of bagging to \$1.31 per 100 bags. This was a 30-percent saving, or 57 cents per 100 bags, over the 3-man crew method.

A scale having a clamp to hold the bag to the spout during filling slowed the rate of bagging to 222 per hour and increased labor and equipment costs by 25 percent, from \$1.38 to \$1.73, per 100 bags.



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Figure 6.--Sewer closing one bag.
Second bag is moving on conveyor
from scale to sewing machine head.

Figure 7.--Sewer closing bag with
portable machine.

A stationary model sewing machine equipped with conveyor for moving bags from the scale to the sewing machine increased the output rate from 324 to 353 bags per hour. Labor and equipment costs remained nearly the same at \$1.30 per 100 bags. It is estimated that a 2-man crew using this type of equipment should be able to fill 428 bags per hour if the scale operated properly. Labor and equipment costs would then be reduced to \$1.15 per 100 bags instead of \$1.30 as shown in table 2.

Replacing the stationary sewing machine and dolly platform with a portable machine reduced the labor and equipment cost for filling 100 bags to \$1.22. The addition of a conveyor for moving bags from the sewing machine increased the bagging rate from 324 up to 375 bags per hour and reduced the cost of filling 100 bags to \$1.09.

Table 2.--Labor and equipment costs for 7 methods of bagging and sewing 100 bags of beans (100 lb. per bag); plant output, 100,000 bags per year

Equipment and method <u>1/</u>	Crew size	Elapsed time	Labor required	Costs		
				Labor	Equipment	Total
				<u>2/</u>	<u>3/</u>	
	<u>Men</u>	<u>Minutes</u>	<u>Man- minutes</u>	<u>Dollars</u>	<u>Dollars</u>	<u>Dollars</u>
Stationary sewing machine:						
Dolly platform:						
No bag clamp on scale.....	3	20.0	60	1.50	0.38	1.88
No bag clamp on scale.....	2	20.0	40	1.00	.38	1.38
Bag clamp on scale.....	2	27.0	54	1.35	.38	1.73
Crew alternating jobs.....	2	18.5	37	.93	.38	1.31
Belt conveyor.....	2	17.0	34	.85	.45	1.30
Portable sewing machine, crew alternating jobs:						
Filled bags loaded onto handtruck.....	2	18.5	37	.93	.29	1.22
Filled bags loaded onto conveyor.....	2	16.0	32	.80	.29	1.09

1/ Semiautomatic, portable bagging scale (capacity - 3 bushels) used in all studies.

2/ Labor at \$1.50 per hour.

3/ See table 3 for ownership and operating costs.

Table 3.--Ownership and operating costs for equipment used in bagging and sewing 100-pound bags of dry edible beans; plant output, 100,000 bags per year

Equipment	Equip- ment cost <u>1/</u>	Ex- pect- ed life	Annual cost of ownership				Annual cost of operation			Total annual cost	Cost per 100 bags
			Depre- ciation	Inter- est <u>2/</u>	Insur- ance and taxes <u>2/</u>	Total	Power <u>3/</u>	Main- te- nance	Total		
			<u>Dollars</u>	<u>Years</u>	<u>Dollars</u>	<u>Dollars</u>	<u>Dollars</u>	<u>Dollars</u>	<u>Dollars</u>	<u>Dollars</u>	<u>Cents</u>
Scale, bagging, 3-bushel, floor, portable.....	1,285	10	128.50		35.34	51.40	215.24		10.00	10.00	225.24: 23
Sewing machine, stationary, manually op- erated dolly platform, foot control switch:	750	20	37.50		19.69	30.00	87.19	4.33	56.00	60.33	147.52: 15
Sewing machine, stationary, 6- foot conveyor model, foot control switch:	1,350	20	67.50		35.44	54.00	156.94	7.09	56.00	63.09	220.03: 22
Sewing machine, portable.....	287	20	14.35		7.54	11.48	33.37	.51	26.00	26.51	59.88: 6

1/ F.O.B. Factory; does not include freight or tax.

2/ Interest at 5 percent of initial investment; insurance and taxes at 4 percent of initial investment.

3/ Rate estimated at \$0.03 per kilowatt hour.

HANDLING BAGGED BEANS IN STORAGE

At the time of the studies bagged beans generally were transported within Michigan elevators with handtrucks designed to carry 5 bags or with fork trucks carrying from 24 to 30 bags on a 48-inch by 60-inch pallet. Belt or drag conveyors were also used to move bags from a bagging and sewing area to the storage or shipping area.

Bagged beans usually were stored in carload lots of 800 bags or more and stacked 18 to 22 bags high. Bags can be stored directly on wooden floors but wood dunnage is recommended over a concrete floor to prevent deterioration of beans in the bottom bags. Fork trucks or belt conveyors generally were used to transport and stack bagged beans in storage.

With one method studied a fork truck picked up and transported a loaded pallet to the stacking area and raised the load into position so workers standing on the stack could remove the bags from the pallet (fig. 8). A 2-man crew with one man operating the fork truck and also helping the second man to pile the bags unloaded a 30-bag pallet in 3.3 minutes. The fork truck required 1.3 minutes to set down an empty pallet and to pick up and transport a loaded pallet 66 feet and position it for unloading. Therefore, the total labor requirement was nearly 31 man-minutes per 100 bags.

A lightweight, portable belt conveyor, 10 to 24 feet long, was satisfactory for stacking bagged beans (fig. 9). A 4-man crew generally was used, with one man handtrucking bags to the conveyor, a second man moving the bags from the handtruck to the conveyor which raised the bags up to two men working on top of the stack. Studies were made on a 16-foot belt conveyor with a belt speed of 65 feet per minute. One handtrucker transported the filled bags 25 feet from a temporary storage block to the elevating conveyor. With this method a 4-man crew, including the handtrucker, stacked bags at the rate of 100 bags in 16 minutes. The labor required was 64 man-minutes per 100 bags.

LOADING BAGGED BEANS FOR SHIPPING

Bagged beans generally are shipped in rail cars or in semitrailer trucks. A standard load for a rail car is 800 bags, or about 80,000 pounds, and for a semitrailer truck 300 to 340 bags.

Rail Cars. Bags usually are stacked 8-high in a rail car. In the studies two men with handtrucks transported 800 bags 35 feet and loaded them into a rail car in 1.3 hours with a labor requirement of 2.65 man-hours. The setup and cleanup operations included sweeping the car, placing the bridge plate at the car door, lining the car with heavy paper, removing the bridge plate when car was loaded, and closing the car door. Required time and productive labor is shown in the following tabulation:

Job element	Productive labor required <u>Man-hours</u>
Setup and cleanup.....	0.32
Pick up bags with handtruck.....	.29
Transport loaded and empty 35 feet:.....	.99
Load car.....	<u>1.05</u>
Total labor.....	2.65
Elapsed time: 1.32 hours	

Semitrailer Truck. Bags usually are stacked 5-high in a semitrailer truck. In the studies two men with handtrucks transported 300 bags 35 feet and loaded them into a truck in 0.37 hour (22 minutes) with a labor requirement of 0.74 man-hour. The setup and cleanup operations included placing the bridge plate in position for loading and removing it after loading. The following tabulation shows the time and productive labor required for the various operations:

Job element	Productive labor required <u>Man-hours</u>
Setup and cleanup.....	0.01
Pick up bags with handtruck.....	.11
Transport loaded and empty 35 feet.....	.37
Load trailer.....	<u>.25</u>
Total labor.....	0.74
Elapsed time: 0.37 hour	



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Figure 8.--Two men stacking bags from fork truck pallet.



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Figure 9.--Portable conveyor used to elevate bags to top of stack.

*Saw even
at Bottom*



Growth Through Agricultural Progress









